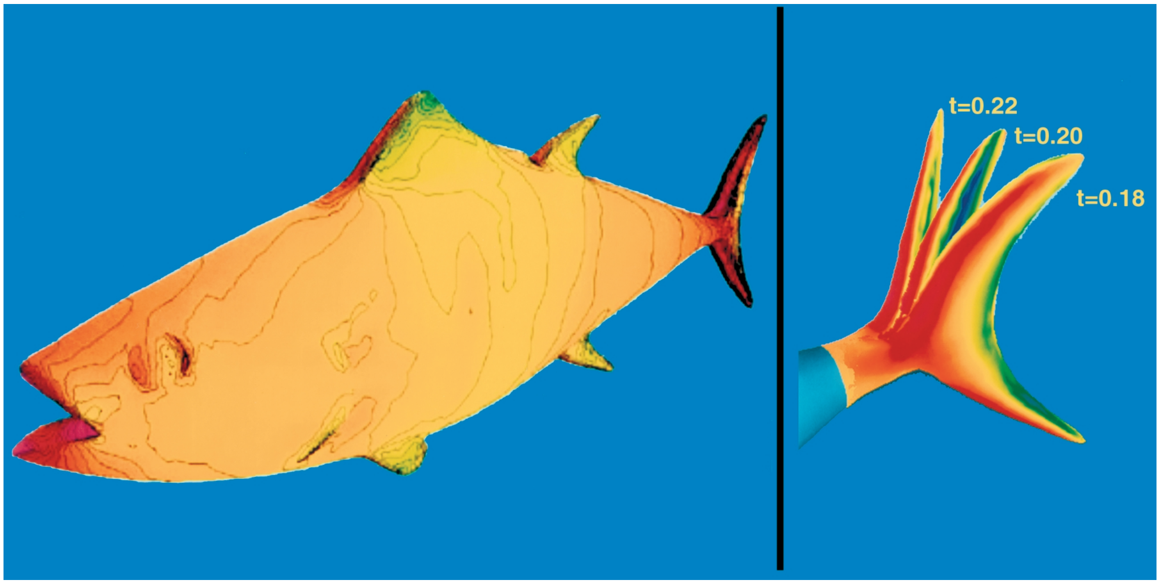
# FLUID DYNAMICS

# Unsteady Flow Past 3-D Deforming Surfaces




Tuna Caudal Fin Oscillation
Body and tail Pressure Variations

Tuna are classified as thunniform swimmers. They generate propulsive thrust primarily from oscillation of their caudal fin. They are, therefore, good candidates for investigation as biological analogues of submersibles with moving stern control surfaces. Understanding of the unsteady fluid dynamics of caudal fin thrust generation may lead to improvements in control surface design for both propulsion and maneuvering. The graceful, seemingly effortless motions of swimming fish have fascinated people for thousands of years. Until recently, it has not been possible to numerically study the unsteady fluid dynamics associated with fish swimming. At the Naval Research Laboratory, we have been applying the latest advances in computational technology to investigate the basic fluid dynamics of thrust production in fish swimming. A 3-D incompressible unsteady flow solver based on finite dynamics with adaptive re-meshing and grid movement has been shown to successfully compute the flow about continuously deforming and oscillating surfaces, as in the tuna shown above. Comparison of these computational results with the more usual quasi-steady state computations has shown that both magnitude and the trend of the forces requires a fully unsteady computation in order to be accurately captured. The insights into thrust production, coming from these investigations, will be useful in designing control surfaces to meet the needs of the submersible community.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